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or about 10° square. An exposure of about twenty minutes on a good night will give impressions of stars of about 11th or 12th magnitude and good measurable images of 10th magnitude stars. As an example of the work possible with this lens, on December 29, 1902, with the camera strapped on the 6-inch equatorial, an exposure was made for $1^h\ 13^m$ of the region around asteroid (385) 10.1 magnitude, and a distinct trail was found very near the computed position of the asteroid.

A description of the photographic equatorial would not be complete without mentioning those connected with its construction. The heavy castings and their patterns were made by the California School of Mechanical Arts; the heavy machine work is by the J. A. Gray Machine Co.; the composition castings are by the Eureka Foundry; and the circles were graduated by the A. Lietz Co.; all of San Francisco. All other parts of the instrument were constructed by Mr. VALDEMAR ARNTZEN, of the Department of Civil Engineering. He has done all of the finer instrumental work, and also helped in solving several knotty problems in the designing.

No work has been done as yet with this instrument; but it is hoped that it will be possible in the near future to present to the Society a satisfactory report of its work.

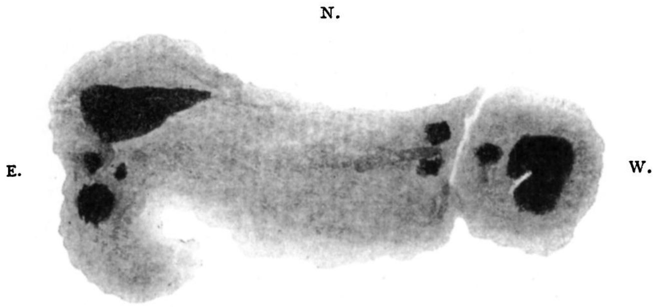
A FEW DETAILS OF THE TWELVE-YEAR SUN-SPOT CYCLE.

By ROSE O'HALLORAN.

Though regularity in the increase and decline of solar activity first led to a recognition of sun-spot periods, still each cycle of change has its individual traits, tendencies, and occasional discrepancies. The cause of periodicity being entirely unknown, such details are of interest, as they may be more than unimportant casualties. The following brief summary of observations from November 1, 1891, to November 1, 1903, contains some of the characteristics of the prolonged cycle that occurred between these dates. According to Professor WOLFER'S revision of sun-spot data, a marked minimum took place early in 1890. This extreme stage of unspottedness did not recur until the summer of 1902; while the last maximum, which showed its approach towards the end of 1891, had its corresponding stage only in October of 1903, so that, dating the cycle either from the extremes of minima or from incoming maxima, its duration was beyond the average period of eleven and one tenth years.

As I used a Brashear refractor four inches in aperture, only very small faint spots were undiscernible in clear weather. When visiting the line of totality of the eclipse of 1900 an interruption of some length occurred, but it makes little change in the outline of decreased spottedness, as the minimum was far advanced. One aim of these observations has been to note the number of times that the photospheric whiteness of the disk has been noticeably invaded. A discolored area, whether stained by one spot or by many, is classed as one disturbance when the sprinkling does not extend beyond twenty-five degrees of the Sun's surface, which, being about the limit of the largest spots, gives some clew as to the probable range of a single eruption. This method, though giving a far less numerical result than if each fragment of a discoloration were counted, avoids including any spot more than once.

From November 1, 1891, to the same date of 1903, the Sun was observed and the results recorded on 2,982 days, and, according to the method adopted, 811 spotted areas were seen on the disk during that time. Two thirds of the disturbances occurred within the first five years, the remainder being distributed over the ensuing years with decreasing frequency until September, 1902, when a slight but distinct increase of activity set in. Of the entire number, about forty sufficiently conspicuous to be visible under favorable conditions without magnifying power may be classed as large; and formations which, from depth of hue combined with enormous extent, were distinctly visible to the world at large crossed the disk on four notable occasions. The first, one of the greatest on record, 150,000 miles in length and 75,000 in breadth, was fully inside the southeast limb on the 4th of February, 1892, and with many changes and divisions continued in view until the 17th. The second, when central in the southern hemisphere, on the 6th and 7th of August, 1893, was nearly 100,000 miles in length, and with much stability of color and form crossed the disk among a dozen smaller eruptions sprinkled over the spot zones. The third, with compact umbra and enormous penumbra, tinged the southerly tracts from the 2d to the 15th of September, 1898. In one respect it was the most remarkable spot of the cycle. The maximum climax was five years past, the minimum was approaching, when some irresistible counter force shattered the law of quietude over an area 140,000 miles in length. The same hemisphere was also the background of the interesting group of last October. With diversified phases, it lingered from the 5th to the 17th of the month, and, though unequal to the first and third in extent, it far surpassed any sun-storm within the previous five years.



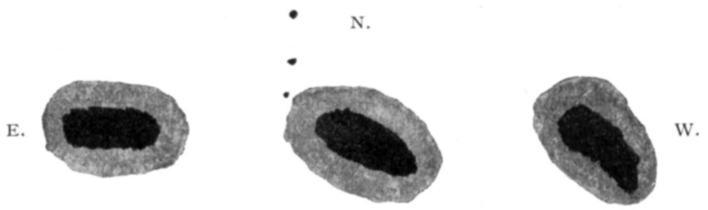
Great Sun-Spot, August 7, 1893.

There is good evidence that many of the large spots were of long duration, and came to view by rotation more than once, but change of form and of position renders complete identification impossible. As in the previous cycle, from 1879 to 1890, the northern zones were more quiescent on the whole than the southern, but the distribution was less unequal, being in the proportion of about seven to ten. This estimate was deduced from 567 disturbances distinctly beyond equatorial zones, as without accurate instruments for the measurement of heliographic latitude perspective effects are misleading at certain seasons.

During the years of maximum, spots frequently appeared in latitudes far from the equator, but from 1897 to 1901 more central zones were chiefly the scene of the diminishing activity, while later a scattering of forces was resumed, which is often a symptom of returning maxima.

In May, 1894, three fourths of the solar circumference was strewn with spots of average size from about twenty to thirty degrees apart; and lesser displays of streaminess were also noticeable three times in 1895, once in 1896, and again in 1898.

As M. FAYE, the French scientist, considers sun-spots to be vortical formations, a whirling tendency is a detail of interest, especially when contrary to the hands of a watch in the southern hemisphere of the Sun, and the reverse in the northern.



March 29th. April 1st. April 4th.

Cyclonic Sun-Spot, 1899.

Such cyclonic motions were detected in January, 1892, in April, 1899, and also less conspicuously on several other occasions.

On August 25, 1894, the disk was freer from discolorations than on any day when observed during the previous two years and ten months, which included 630 observations. From this time forward an unblemished photosphere was more frequently seen, and days, weeks, and finally months of undisturbed whiteness announced that maximum had gradually given place to minimum. Eighty-six days of unspottedness were distributed throughout 1901, and 147 days throughout 1902. In the latter year, from June 6th to September 11th, when an unspotted disk was viewed on 91 days, the extreme stage of minimum seems to have occurred. After a week of cloudy weather two spots appeared on the 19th of September, and thenceforth a slight increase of spottedness was evident until October, 1903, when the present maximum commenced.

Shadings in the granulated solar surface, often noticeable with a high power on clear days, have been ignored in this summary of observations.

SAN FRANCISCO, CAL.